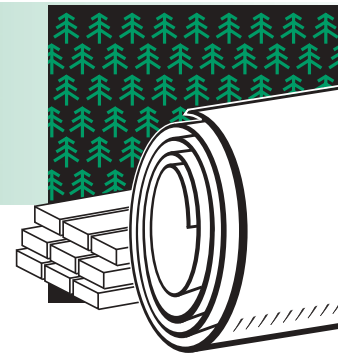


# FOREST PRODUCTS

## Project Fact Sheet



## MOLECULAR PHYSIOLOGY OF NITROGEN ALLOCATION IN POPLAR

### BENEFITS

- Efficient use of nitrogen and greater production of stem biomass per unit of nitrogen
- Reduction of production costs on fiber farms
- Use of altered trees as biofilters to scavenge nitrogen from soils and prevent nitrate run-off into nearby environmentally sensitive areas
- Improvement in yield of hardwood plantations
- Enhancement of the U.S. forest industry's global competitiveness

### APPLICATIONS

Once the early response of trees to fertilization is better understood, industry can use more, cost-effective strategies for applying nitrogen in tree farms; the timing and quantity of the application can be closely matched to specific requirements of the trees.

## MANIPULATION OF NITROGEN-RESPONSIVE GENES CAN INCREASE POPLAR PRODUCTIVITY

Genetically manipulated tree lines that use nitrogen fertilizers more efficiently will help foresters increase productivity and lower costs. More knowledge is needed of the short-term physiological changes and genetic responses in hardwood trees after nitrogen is applied in intensively managed tree farms. The routine application of nitrogen stimulates maximum vegetative growth during the juvenile stages of tree growth, but some genotypes respond better than others to the nutrients. Understanding the sequence of events from the time nitrogen enters the soil solution until a growth response occurs will help researchers explore the potential to genetically manipulate these events.

The long-term goal is to create transgenic tree lines that exhibit a greater uptake of nitrogen, and are therefore more productive in tree farms than average genotypes.

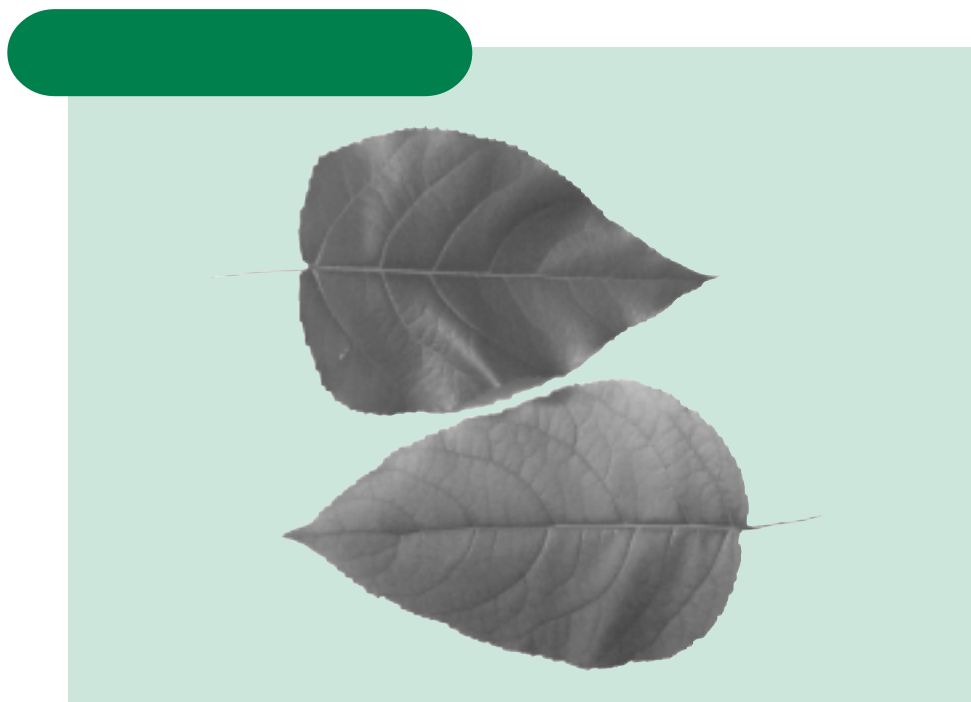


Figure 1. Nitrogen (N) is important for proper development and functioning in poplar leaves. Leaves from the same poplar clone are shown, the upper one grown under adequate N supply and the lower one in which N was limited.



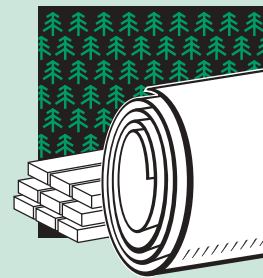
## Project Description

**Goal:** To determine the mechanisms that regulate the biochemical and genetic physiology of poplar trees with regard to nitrogen utilization

Poplars will be used for these studies because of their very large capacity for nitrogen uptake. Genes and processes that are affected by nitrogen fertilization will be determined, and the sequence of changes in the roots, stems, leaves, and shoot tips will be described. Based on its relative abundance at various stages after fertilization, genetic material will be identified and cloned (as cDNA) and sequenced. Researchers will build a "biochemical roadmap" for the poplar that shows the processes and genes that are "indicators" of nitrogen-regulated responses in tree structures. The long-term goal is to produce trees that direct a higher proportion of nutrients into their growth than do average tree lines, by genetic engineering of poplar genes known to be nitrogen-responsive. This will be accomplished in part by reducing the nitrogen-storage capacity of the leaves (genetically) so more of the fertilizer is allocated to stems and the apical meristems.

## Progress & Milestones

- The project began in May 1997 as a three-year project.
- April 1998: Antisense gene constructs were made and sent to Union Camp.
- January 1999: Nitrogen-responsive cDNAs were cloned and sequenced.
- January 1999: Transgenic lines were screened for kanamycin resistance.
- July 1999: Transgenic lines were sent to UFL.
- Researchers identified the practical outcome of their research as, "transgenic trees with greater nitrogen use efficiency."
- Results indicated that nitrogen and carbon metabolism were intimately linked in the *Populus* nitrogen response roadmap (NRR).
- In a proposed follow-on effort, investigators will determine how the NRR specifically affects wood properties in *Populus*.



### PROJECT PARTNERS

Washington State University  
Seattle, WA

International Paper  
(formerly Union Camp Corporation)  
Purchase, NY

### FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

David Boron  
Office of Industrial Technologies  
Phone: (202) 586-0080  
Fax: (202) 586-3237  
E-mail: david.boron@ee.doe.gov

Dr. John Davis  
University of Florida  
Phone: (352) 846-0879  
E-mail: jmdavis@ufl.edu

Visit our home page at  
[www.oit.doe.gov](http://www.oit.doe.gov)

Office of Industrial Technologies  
Energy Efficiency and  
Renewable Energy  
U.S. Department of Energy  
Washington, D.C. 20585



February 2001